International Journal of Civil Engineering (IJCE)
ISSN (P): 2278–9987; ISSN (E): 2278–9995
Vol. 9, Issue 2, Feb–Mar 2020; 1–8

International Academy of Science, Engineering and Technology
Connecting Researchers; Nurturing Innovations

EXPERIMENTAL STUDY ON GLASS POWDER CONCRETE

N. Anusha & P Jyothi

Assistant Professor, Qiscet, Ongole, India

ABSTRACT

The usage of cement as a binder in concrete gives good results, but it is harmful to the environment because of the release of harmful gases like carbon monoxide and carbon di oxide into the atmosphere. This paper attempts to use Glass powder as a partial replacement of cement, which is rich in silica. It is planned to prepare the concrete specimens in the form of cubes and cylinders and compare the strength characteristics of the replaced concrete with the conventional concrete. It is planned to add the glass powder as a replacement of cement as 5%, 10% etc., with the weight of the cement and it will be finally concluded with the percentage replacement giving the best result. In this paper, glass powders are used as a replacement of binder, which is a waste material thus it is highly environmental friendly and economical as well.

KEYWORDS: *Silica, Compaction, Glass Powder, Waste Glasses, Strength*

Article History

Received: 17 Feb 2020 | Revised: 25 Feb 2020| Accepted: 29 Feb 2020

INTRODUCTION

Concrete is the most widely used building material construction industry. It is a homogeneous mixture of cement, fine aggregate, coarse aggregate and water [1].The proportion of cement is mainly responsible for the strength of concrete [2]. Cement is a finely pulverized homogeneous material [3] Due to the hydration, the cement acts as a binding material in the concrete [4]. The Silica present in the cement accelerates the binding nature. The objective of the study is i) To evaluate the utility of Glass powder as a partial replacement of cement in concrete ii) To study and compare the performance of conventional concrete and Glass powder concrete iii) To estimate and understand the effectiveness of glass powder in strength enhancement.

METHODOLOGY

Figure 1.

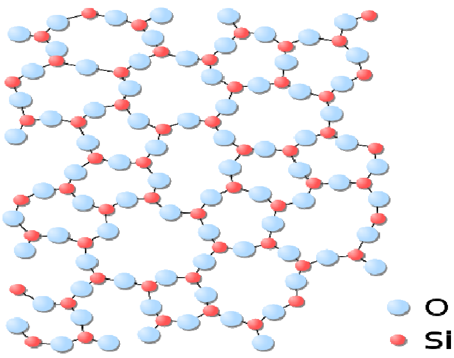


Figure 2.

Source of Glass: Structure of Glass

Constituents of Glass

Table 1

Name of Constituent	% of constituent
Lime (CaO)	62%
Silica (SiO_2)	22%
Alumina (Al_2O_3)	5%
Calcium Sulphate ($CaSO_4$)	4%
Iron Oxide (Fe_2O_3)	3%
Magnesia (MgO)	2%
Sulphur (S)	1%
Alkalies	1%

Properties of Glass

Glass is an amorphous (non-crystalline) that in essence. Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibers to meter-sizes pieces. The constituents of glass are sand, soda ash, limestone and other additives (Iron, Chromium, Alumina, Lead and Cobalt) as listed above. Glass has been a replacement of aggregates in road construction, building and masonry materials in the present times.

EXPERIMENTAL WORK

The various sources of waste glass are places such as construction sites, industries, etc.., from which the glass waste is collected. Then it is crushed and ground to a size, fine enough to achieve it is Pozzolanic behavior. Cement is now partially replaced by its weight, by glass powder at varying rates such as 5%, 10%, mixed with glass powder at different rates. With these results, the control mix, utilizing glass powder replaced as cement is to be designed for cylinders and cubes. Now, 4 cylinders – and 4 cubes- such as four specimens for each combination is to be casted for the whole and cured at room temperature. At the end of curing period, each specimen is tested for compressive and tensile strength and the average is recorded.

Figure 3: Broken Glass.

Figure 4: Broken Procedure Test.

Figure 5: Glass Pieces

Figure 6: Glass Powder.

Compressive Strength

The specimen Measure the dry proportion of ingredients (Cement, Sand & Coarse Aggregate and Glass powder) as per the design requirements. In this test, we are using 5 and 10% of glass powder as replacement of cement. The Ingredients should be sufficient enough to cast test cubes. Thoroughly mix the dry ingredients to obtain uniform mixture. Add design quantity of water to the dry proportion (water-cement-ratio). Mix well to obtain uniform texture. Fill the mould with concrete to compact with the help of vibrator for thorough compaction. Now finish the top of the concrete cube mould by trowel & see that the cement slurry comes to the top of the cubes by tapping or vibration.

Testing

Now place the concrete cubes into the testing machine, centrally. The cubes should be placed correctly to the machine plate (check the circle marks on the machine). The load will be applied to the specimen axially. Now slowly apply the load, gradually. The maximum load at which the specimen breaks is taken as a compressive load. In this test, we are using M25 grade.

Figure 7: Testing of Compressive Strength of Specimen.

Test Result

Compressive Test

Compressive strength= Applied load /cross sectional area.

Table 1: Compressive Strength of Conventional Concrete in 3 days

S. No	Dimensions in mm	Load in k N	Compressive Strength in N/ mm^2
1	150*150*150	195	8.7
2	150*150*150	210	9.3
3	150*150*150	230	10.22
4	150*150*150	245	10.88

Table 2: Compressive Strength of Conventional Concrete in 7 days

S. No	Dimensions in mm	Compressive	
		Load in KN	Strength in N/ mm^2
1	150*150*150	255	11.33
2	150*150*150	270	12
3	150*150*150	287	12.755
4	150*150*150	295	13.11

Table 3: Compressive Strength of Cubes with 5% Replacement (3 days of Curing)

S. No	Dimensions in mm	Compressive	
		Load in k N	Strength in N/ mm^2
1	150*150*150	335	14.88
2	150*150*150	310	13.77
3	150*150*150	350	15.55
4	150*150*150	340	15.11

Table 4: Compressive Strength of Cubes with 10% Replacement (3 days of Curing)

S. No	Dimensions in mm	Compressive	
		Load in k N	Strength in N/ mm^2
1	150*150*150	385	17.11
2	150*150*150	360	16
3	150*150*150	370	16.44
4	150*150*150	392	17.422

Table 5: Compressive Strength of Cubes with 5% Replacement (3 days of Curing)

S. No	Dimensions in mm	Compressive	
		Load in k N	Strength in N/ mm^2
1	150*150*150	425	18.88
2	150*150*150	430	19.11
3	150*150*150	420	18.666
4	150*150*150	442	19.644

Table 6: Compressive Strength of Cubes with 10% Replacement (7 days of Curing)

S. No	Dimensions in mm	Compressive	
		Load in KN	Strength in N/ mm^2
1	150*150*150	475	21.11
2	150*150*150	490	21.888
3	150*150*150	485	21.555
4	150*150*150	495	22

Tensile Strength

This test method consists of applying a diametrical force along the length of a cylindrical concrete at a rate that is within a prescribed range until failure. This loading induces tensile stresses on the plane containing the applied load and relatively high compressive stresses in the area immediately around the applied load. Although we are applying a compressive load but due to Poisson's effect, tension is produced and the specimen fails in tension. Tensile failure occurs rather than compressive failure because the areas of load application are in a state of tri axial compression, thereby allowing them to withstand much higher compressive stresses than would be indicated by a uniaxial compressive strength test result.Thin, plywood bearing strips are used to distribute the load applied along the length of the cylinder. The maximum load sustained by the specimen is divided by appropriate geometrical factors to obtain the tensile strength.

Figure 8: Testing of Tensile Strength of Specimen.

Test Results

Tensile Test

Tensile strength (MPa) = 2P/πDL, Where P=failure load, D=diameter of cylinder, L = length of cylinder.

Table 7: Tensile Strength of Conventional Concrete Cylinders (3 days of Curing)

S. No	Dimensions in mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150 mm dia,300 mm height	60	0.84
2	150 mm dia, 300 mm height	75	1.06
3	150 mm dia, 300 mm height	78	1.1034
4	150 mm dia, 300 mm height	83	1.174

Table 8: Tensile Strength of Conventional Concrete Cylinders (7 days of Curing)

S. No	Dimensions im mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150 mm dia,300 mm height	80	1.13
2	150 mm dia,300 mm height	95	1.343
3	150 mm dia, 300 mm height	88	1.244
4	150 mm dia, 300 mm height	99	1.4

Table 9: Tensile Strength of Concrete with 5% Replacement (3 days of Curing)

S. No	Dimensions in mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150 mm dia,300 mm height	69	0.976
2	150 mm dia,300 mm height	78	1.103
3	150 mm dia, 300 mm height	83	1.174
4	150 mm dia, 300 mm height	89	1.259

Table 10: Tensile Strength of Concrete with 10% Replacement (3 days of Curing)

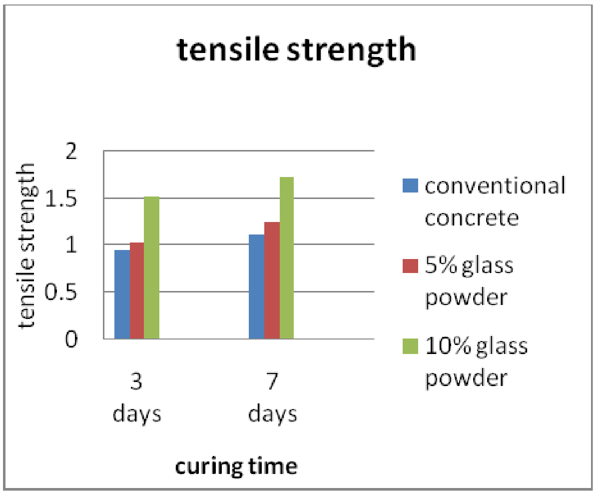
S. No	Dimensiona in mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150 mm dia,300 mm height	84	1.188
2	150 mm dia,300 mm height	93	1.315
3	150 mm dia, 300 mm height	98	1.384
4	150 mm dia, 300 mm height	105	1.485

Table 11: Tensile Strength of Concrete with 5% Replacement (7 days of Curing)

S. No	Dimensions in mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150mm dia,300 mm height	110	1.556
2	150 mm dia,300 mm height	105	1.485
3	150 mm dia, 300 mm height	113	1.598
4	150 mm dia, 300 mm height	119	1.683

Table 12: Tensile Strength of Concrete with 10% Replacement (7 days of Curing)

S. No	Dimensions in mm	Tensile	
		Load in kn	Strength in n/ mm^2
1	150 mm dia,300 mm height	125	1.768
2	150 mm dia,300 mm height	120	1.697
3	150 mm dia, 300 mm height	130	1.839
4	150 mm dia, 300 mm height	138	1.952



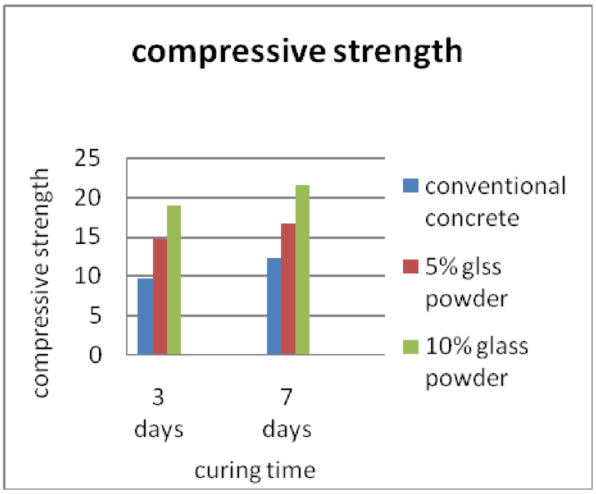


Figure 9: Showing Test Results of Compressive Strength and Split Tensile Strength.

4. RESULTS & CONCLUSIONS

Conventional concrete shows a 3 days compressive strength, as 9 N/mm^2 and tensile strength of 0.95N/mm^2.5% replacement of glass powder in cement increases the compressive strength by 37% in 3days of curing and 38% for 7 days of curing. 10% replacement of glass powder increases the compressive strength by 52.6% in 3days of curing and 54.6% after 7 days of curing. 10% replacement of glass powder in cement will increase the tensile strength by 39.8% in 3 days and 7 days. Hence, it is suggested to add 10% of glass powder as a replacement to the cement by weight.

REFERENCES

1. *M.S. Technology Theory Shetty, "Concrete and Practice" (S.Chand and Company Ltd.New Delhi, 2006).*
2. *M.L.Gambhir, "Concrete Technology", (Tata McGraw-Hill Publishing Company Limited, New Delhi, 2006)*
3. *M.S.Shetty, "Concrete Technology Theory and Practice"S.Chand and Company Ltd., New Delhi, 2006 219-225*
4. *M.L.Gambhir, "Concrete Technology", Tata McGRAW-Hill Publishing Company Limited, New Delhi, 2006. Pozzolana, Strength, Supplementary cementitious material, Workability, Waste glass powder.*

5. *Aimin Xu and Ahmad shayam, "Value –added utilization of waste glass in concrete", Cement and concrete research, vol.34, 8189, 2004.*
6. *Pereira de Oliveira. L.A, J.P. Castro –Gomes, P. Santos, "Mechanical and Durability Properties of concrete with Ground waste Glass Sand", International conference on durability of Building Materials and components, Turkey, 2008. International Conference on Advances in Engineering & Technology – 2014 (ICAET-2014) 60 | Page.*
7. *Byars, E. A., Morales, B.Zhu, H. Y. (2004a).ConGlassCrete I. [Online] Centre of Cement and Concrete. University of Sheffield. Published by: The Waste and Resources Action Programme. Available at: http://www.wrap.org.uk/downloads/ConGlassCrete1FinalBodyi.c242a657.445.pdf [Accessed 5 October 2008]*
8. *University of Dundee. (2005). Recycled Glass. Use of Recycled Materials and Industrial by-Products in Concrete. [Online]. Available at: http://www.greenconcrete.dundee.ac.uk/RecycledGlass-t.htm[Accessed 5 October 2008]*
9. *Waste cycle, Recycle Glass with Waste cycle, 2007[Home page] [online]. Nottinghamshire: WastecycleLtd [cited 16 October 2007].*
10. *Indian Standard code of practice for plain and Reinforced Concrete, IS456:2000, Bureaue of Indian Standards, New Delhi.*
11. *Recommended guidelines of concrete mix design, IS 10262:1982, Bureau of Indian Standards, New Delhi.*
12. *Sprince, A., Pakrastinsh, L., & Korjakins, A. (2011). Experimental study on creep of new concrete mixtures. Civil Engineering, 35, 36.*